ONTARIO

Kawartha Lakes – Trent River

Water Management Study
Field Methodology

1972

Environment Ontario

KAWARTHA LAKES - TRENT RIVER

WATER MANAGEMENT STUDY

FIELD METHODOLOGY

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KAWARTHA LAKES WATER MANAGEMENT STUDY

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INTRODUCTION

It has been recognized by biologists and scientists that a number of Ontario's relatively shallow, recreational lakes systems such as the Kawartha Lakes are affected by a type of pollution scientifically known as eutrophication or aquatic enrichment. Characteristics of such lakes include the production of extreme numbers of algae and weeds which develop in response to high concentrations of nutrients in the water.

It must be stressed that <u>all</u> lakes are subject to inputs of dissolved mineral substances and resulting sedimentation - specifically substances such as phosphates, nitrates, carbonates and numerous trace elements - increases which occur as a result of precipitation, land run-off and percolation of soil-water to the lake basin. Such inputs augment the fertility of the system, contributing to a <u>natural</u> process of eutrophication. The Kawartha Lakes are extremely productive owing to the fertile soils drained and/or flooded by the creation of the Trent Canal System. These lakes are generally more turbid than Precambrian country lakes owing to the increased phytoplankton production and presence of suspended particulate matter. They support substantial beds of submerged plant such as water milfoil, elodea, coontail and pondweeds and produce excellent yields of warm-water game fish species such as walleye, bass and maskinonge. However, increased enrichment attributable to agricultural run-off, urbanization along the system and the inadequate containment of cottage wastes are presently contributing

to, and will continue to increase the stresses on an already productive environment.

In many of the Kawartha and Rideau lakes, artificial nutrient inputs have increased the production of blue-green algal "water-blooms" and aquatic plants to the point where many activities such as swimming, water skiing and unimpeded boating are practically impossible. Prolonged periods of hot, calm weather have periodically caused decomposition of algae and aquatic plants in stagnant or isolated bays, resulting in dissolved oxygen depletions and accompanying fish mortalities. Also, periodic winter kills of fish resulting from organic decomposition from weed and algal depositions have been a recurring problem.

Forms of algae and weed control

There are currently two basic methods which may be employed for weed control - chemical or mechanical.

Chemical control

Chemical control of weeds can be accomplished following issuance of a permit under Section 38 of the Ministry of the Environment Act. The effectiveness of various herbicides and algicides on both target and non-target plants, as well as regulation of the permits are currently assessed by personnel of the Biology Section of the Ministry of the Environment.

One major disadvantage of chemical control is that a potentially toxic material is introduced into the aquatic environment. In a few isolated instances, excess chemicals have been inadvertently added. On such occasions the short-term effects have been undesirable as aquatic life forms other than weeds and algae have been temporarily eradicated. Of greater significance is that the long-term or residual effects are often not fully understood.

Secondly, chemically-destoyed plants remain in the water where they decompose to release stored nutrients for support of new growth. Additionally, dissolved oxygen depletions resulting from decomposition may undermine the suitability of the aquatic environment for desirable fish species.

Mechanical control

Mechanical control measures usually consist of cutting the plants and collecting the cuttings with either an aquatic harvester or later, in a secondary operation. Removal of the cuttings is essential to avoid nuisances caused by large quantities of drifting and decomposing plants.

Although cost and expediency appear to favour chemical methods, mechanical control or harvesting is considered ecologically more sound. Initially, mechanical removal will not introduce toxicants into the water. Secondly, actual removal of nutrient materials from the lake cycle will result. Recent data from Chemung Lake suggests that nitrogen and phosphorus drains as high as 50 and 6 pounds per acre respectively can be removed per cutting. However, absolute yields will vary from season to season, lake to lake and species to species. Thirdly, mechanical removal if properly carried out will not alter the plant and animal life balances as drastically as chemical treatments, and may in fact, enhance the fisheries of a lake. Finally, mechanical removal provides immediate relief from prolific weed growths.

Efforts re: Water Management

In 1971 scientists of the Ministries of the Environment and Natural Resources and co-operating universities began a study of the Kawartha Lakes system between Balsam Lake and the Bay of

Quinte. The broad objective is to develop a sound water management plan to optimize water use potential. As such, the study will take cognizance of all human, social and economic factors which influence the pattern of water resource utilization throughout the system.

As part of the study, scientists are considering the possibility of removing excessive weed growths with aquatic weed harvesters to improve the potential of a lake to support activities such as swimming, boating, water skiing and yachting. As indicated earlier, it is also possible that such a harvesting programme would create a "nutrient-drain" by the repetitive cropping and removal of plant materials from overly-enriched waters. However, before moving too far in this direction it is imperative to determine what effects weed harvesting will have on the fisheries of a lake. It is entirely possible that large areas of aquatic plants may be removed without damaging fish production and also, that a specific pattern of cutting may actually enhance the fishery. On the other hand, adverse effects might result.

During the summer of 1972 biologists of the Ministries of the Environment and Natural Resources will carry out intensive studies on Lake Chemung to assess biotic relationships in both weedy and adjacent cleared areas, as well as evaluating angling success prior to possible experimental harvesting throuout a significant portion of the lake.

Fate of removed vegetation

From a more practical point of view, any programme aimed at improving environmental quality should be evaluated with a view to ensuring that the solution to one problem does not directly or indirectly give rise to a problem in a second direction.

Thus, one must seriously question the ultimate fate of aquatic vegetation once harvesting and removal have been accomplished. For example, the simplest removal technique, of course, would be to dispose of the material in an area of waste land or swamp close to the lake or river. Transportation cost would be negligible in this case; however, following decomposition it would only be a matter of time before the nutrients released from the plants would percolate into the water to provide raw material for yet another crop. Returning the nutrients to agricultural land is undoubtedly a good approach but, if the vegetation must be transported long distances to suitable farm land, thus consuming large amounts of energy and adding to the congestion on highways, then the benefits are considerably reduced. Aside from this, the nutrient value of aquatic plants is small when compared to commercially available fertilizers and the material would only be a partial substitute for inorganic compounds.

Suggestions currently under consideration for re-cycling the harvested crop, include various types of soil additives and animal feeds. Also, a good deal of interest involving the use of the aquatic plants for paper processing has recently been expressed. However, before a weed harvesting operation and associated re-cycling project can be effected on a large scale, it is absolutely essential to demonstrate the ecological and practical merits on a pilot-plant basis to governmental personnel and the public.

Summary

The benefits to the aquatic resource from mechanical weed removal have yet to be determined, but we are confident that in many areas where severe congestion is resulting from the proliferation of rooted plants, such methods may provide the

only long-term solution to enhancing the multi-purpose potential of our waterways. This possibility must surely be considered when the decision is made to use, or not to use, harvested vegetation for a particular purpose. Any process which will re-cycle raw materials and thereby reduce the quantity of "waste material" within our environment must indeed be attractive in an era when constant "disposal" techniques threaten to overwhelm us.

The entire question of ensuring the best use of Ontario's waterways is extremely complex. The basic need is not one of simply controlling various types of pollution - rather, it is one of defining what is desirable in terms of water resource utilization and then implementing whatever remedial or protective measures are in keeping with sound water management principles.

1972 PROGRAMME

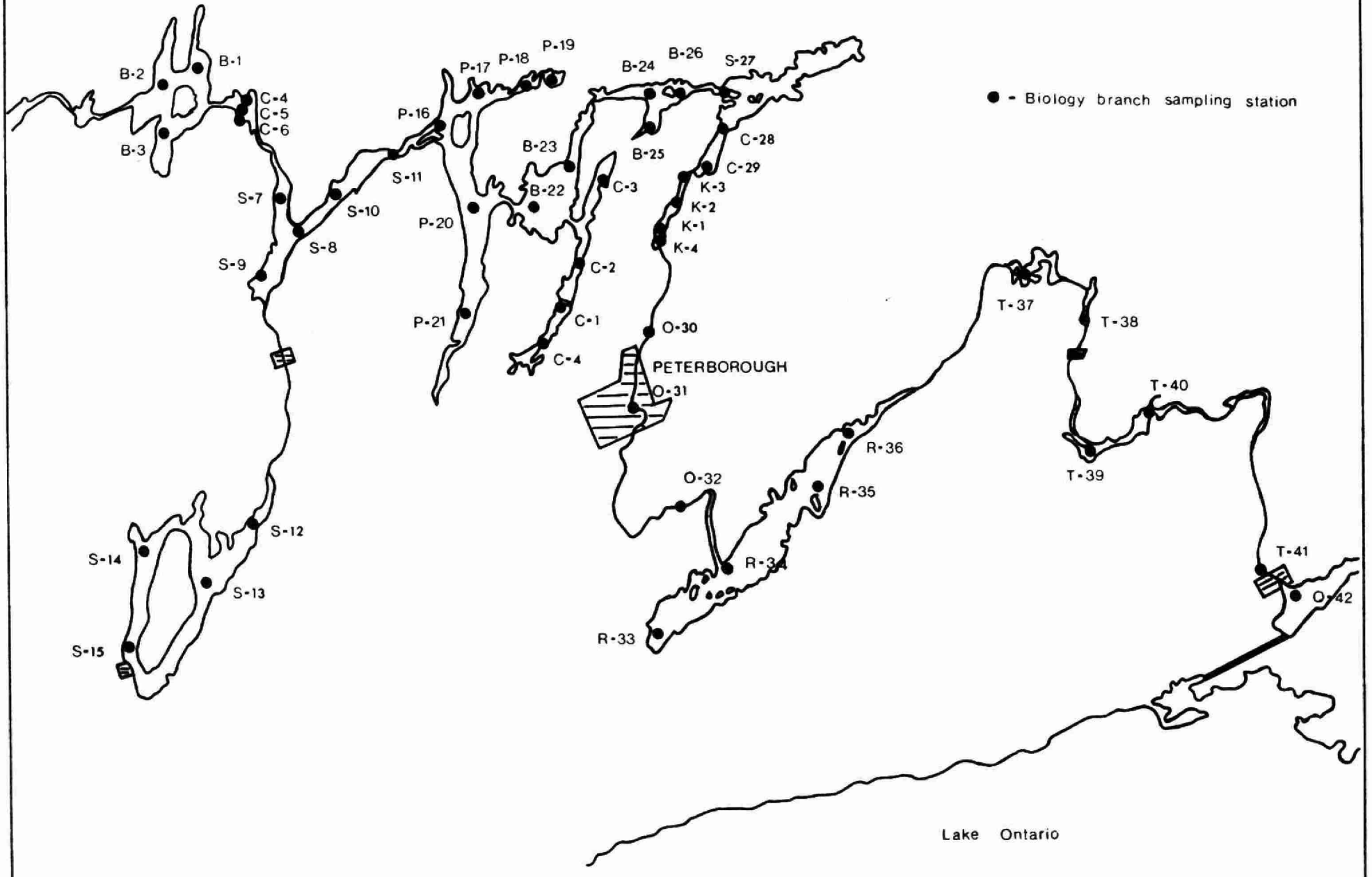
KAWARTHA LAKES - TRENT RIVER SYSTEM

Water Quality Evaluation

Every three weeks between May 8 and October 6, 1972 visits will be completed to approximately 52 main lake and stream stations (Figure 1). See the following section for details on methodology.

Physical properties	-	temperature series
	-	Secchi disc readings
	-	photometer readings - determined in connection with primary productivity estimates.
Chemical	-	field determinations of oxygen.
	-	field determinations of pH, alkalinity, conductivity and free CO_2.
	-	collection of water samples for nutrients, chlorophyll and basic chemical characteristics (composite from euphotic zone and 2m above bottom except chlorophyll with is taken as a composite from the euphotic zone only).
Nutrient content of algae (Chemung Lake only)	-	done on composites from the euphotic zone during the ice-free period (from chlorophyll samples).

Figure 1.



KAWARTHA LAKES - Balsam Lake to Bay of Quinte

Phytoplankton	-	composite from the euphotic zone.
Primary productivity	a)	ship-board primary productivity - done as directed at 52 main lake and stream stations.
	b)	in-situ estimates at four stations located in Chemung Lake each week.
Aquatic Macrophyte Assessment	a)	Chemung Lake Study
	b)	Canal Lake to Bay of Quinte Study.

Special Investigations

a) Spot surveys in connection with waste discharges to the main stem and tributaries (near main-stem). Specific objectives for each survey include an assessment of the degree and extent of effects on water quality and aquatic biota, the documentation of water use conflicts and the delineation of proposed mixing zones.

b) Assessment of extent of vascular aquatic growths using aerial photographic techniques and associated ground truth assessments.

c) Mr. D. Wright will be continuing his study to evaluate the effects of nutrient regeneration from sediments in shallow lakes on phytoplankton communities under aerobic conditions. Work on this aspect of the programme will be carried out in Chemung Lake and the Bay of Quinte.

d) Water chemistry investigations - cation - anion balance carried out at each main lake station once June, August and September.

e) Chemistry of rainfall done as a control for Mr. B. Fallis.

TECHNIQUES

A programme in which a wide variety of techniques is used by numerous investigations, must be planned to provide some uniformity in application to these techniques. However, it is important that procedures do not become altogether stereotyped. The following description of techniques has been prepared to compromise these two opposed objectives.

Secondly, it is essential that the very best practical methods of collection, storage, treatment and analyses of samples be devised, which are still acceptable for routine laboratory analyses. Both the researcher and the laboratory manager must be flexible. The methods described here are to some degree compromised procedures, and, while they appear both useful and practical at the present time, they will be subject to further investigation and change.

Finally, it is important to note that these techniques and procedures for their application have been designed for this specific investigation and within practical limitations.

A. METEOROLOGICAL

1. General

Data on rainfall, winds and temperature are available from the Department of Transport records from Peterborough and are kept on file in our library. In some cases (i.e. Muskoka Lakes report) the recorded data can be incorporated into general limnological background studies.

2. Incident light

Continuous recordings of incident light will be taken at our Mobile Laboratory located at Trent University in Peterborough.

The instrument will consist of a Weston photovoltaic weatherproofed cell and Rustrak A.C. recorder. Photosynthetically active light may be read from the chart by appropriate conversion using calibration data for each instrument. The hourly average levels of incident light will be read from the charts and tabled for subsequent use in estimating primary productivity rates on a daily and seasonal basis for the lakes under study.

B. PHYSICAL PROPERTIES OF LAKE WATERS

1. Temperature

Vertical profiles of water temperature will be obtained at each station between Balsam Lake and the Bay of Quinte and at the four sampling sites in Chemung Lake on each visit employing a thermistor probe. Readings are taken at each meter of depth (although fewer readings will obviously suffice when homothermal or near-homothermal conditions exist). It is important to realize that readings every 0.5 meters will be necessary to define the exact limits of the thermocline during period of stratification. Thermistor probes should be calibrated at least daily against cold and warm water.

2. Light Transmission

Secchi disc

One of the most important parameters used to obtain a clear definition of water quality is an assessment of water clarity in a lake. The Secchi disc is a simple device which measures the transparency of water. The disc is designed to be lowered into the water on a graduated line, with the black and white alternating quadrants side up.

Secchi disc measurements are made by lowering the black and white disc into the water on the shaded side of the boat. The observer should lean over the side of the boat so that his eyes are directly over the disc as it is lowered. When the disc just disappears, the depth is measured and is raised slowly until the black and white segments are just visible. A second reading is then taken. The point half-way between these two

readings is the Secchi disc depth. Reading should be to the nearest 0.1 meters.

For example:

1. lowered until the disc just disappears = 5 meters.
2. raised until the black and white quadrants just re-appear = 4.9 meters.
3. point half-way between (4.9 meters) is the Secchi disc depth.

Secchi disc measurements will be taken at all stations between Balsam Lake and the Bay of Quinte and at the four established stations in Chemung Lake on each visit.

Submarine photometer (if necessary)

1. Secure the deck cell firmly to the deck so that it has an unobstructed view of the sky. It should be placed so that no shadows will fall on the photocell during the course of the measurements.
2. Before use, tighten all screws on the deck and sea cell housings, if necessary, to prevent water leakage. Check the stuffing nut where the cable enters the underwater cell to be sure this is tight.
3. Remove the shorting plugs from the connectors on the cable and connect the sea and deck photocells to their appropriate connectors. Set the SCALE MULTIPLIER to the largest factor (X 800).
4. Set the CIRCUIT SELECTOR switch to on.
5. Record the output from the deck cell, as indicated on the 0-25 milliameter.

6. Lower the underwater unit (sea cell) to the 1-meter level, and switch to lower multiplier values as needed to obtain a scale reading on the 0-25 microammeter of the under-water cell.
7. Lower the sea cell and take corrected (use multiplier) readings from the microammeter scale at every meter of depth and record on deck sheet. Record deck cell reading each time.
8. When all readings have been completed, set the CIRCUIT SELECTOR TO OFF, raise the under-water unit to the deck and remove the deck and sea cell connectors from the meter box and replace the shorting plugs on the cable connectors.

C. WATER CHEMISTRY - LAKE WATERS

1. Field determinations of dissolved oxygen

Generally, oxygen determinations will be sufficient from one point source epilimnion sample (1.0 meter) and one hypolimnion sample (1.0 meter above bottom) during homothermal conditions. However, with the development of thermal stratification (Figure 2), particularly at productive stations, oxygen samples must be collected at every meter within the thermocline to two meters below. Additionally, sufficient collections within the hypolimnion to document its oxygen regime will be required.

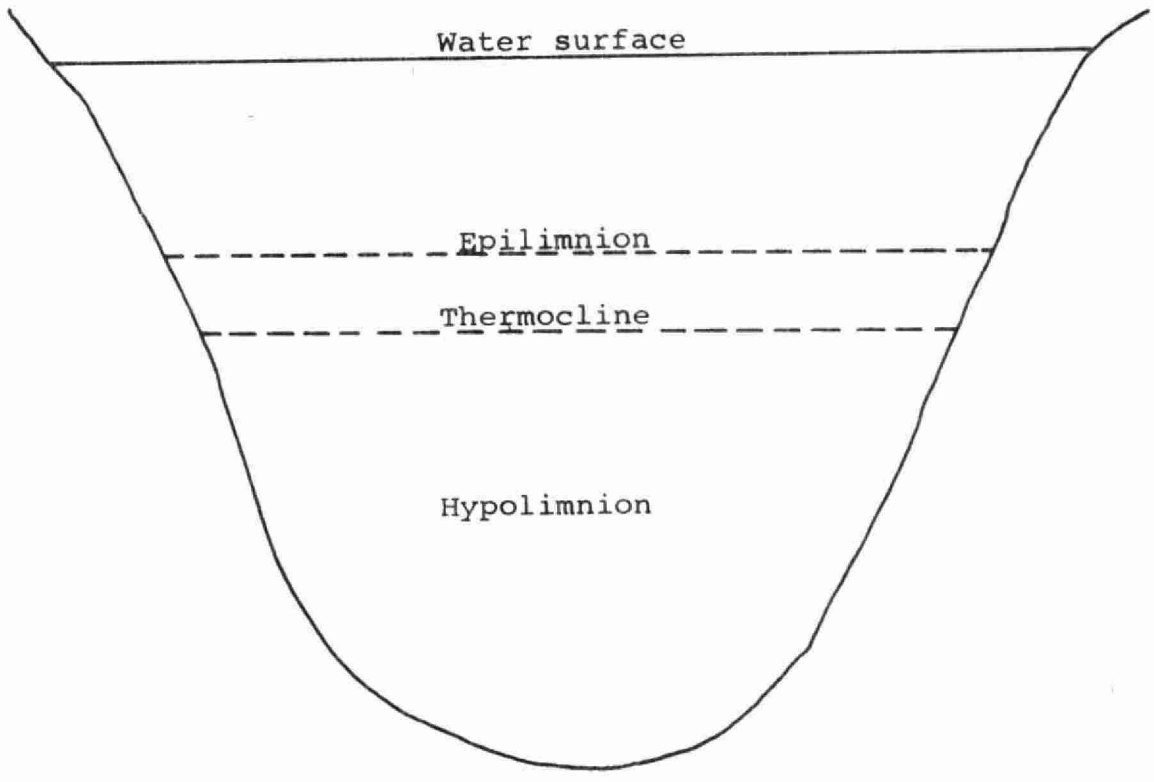
Take the sample from a Van Dorn via tubing into two 36-ml gas bottles, allowing the bottles to overflow once or twice. Stopper immediately and check for trapped air bubbles (if present, repeat). Add 5 drops each of $MnSO_4$ and alkaline azide reagents and stopper without trapping bubbles. After the precipitate settles add 10 drops of H_2SO_4.

Titrate in the field laboratory using .0045 N thiosulphate solution. Stock solution of .0125N thiosulphate will be supplied (dilute 360 mls to 1.0 l. to provide titrating strength). Hold all thiosulphate solutions in the dark at room temperature.

One ml titre equals 1.0 mg/l in procedure above. For analyses see page 19.

It is important that bottles be properly labelled - use masking tape and felt pen.

If oxygen profiles are defined with a YSI meter, it is imperative that daily calibrations be effected against a standard Winkler test.



EPILIMNION - the warm (higher) upper layer of water

THERMOCLINE - the transition layer of rapid temperature change between the upper warm layer and the deep cold water

HYPOLIMNION - the deep cold (heavier) water zone below the thermocline

Figure 2: Section of Riley Lake showing the three layers resulting from thermal stratification.

Special care need be taken in relatively small, deep lakes (especially those which are protected from the wind) as mid-thermocline oxygen increases may develop during the summer months. The documentation of these mid-thermocline increases is extremely important in the classification of lake-type.

2. Field determination of pH, alkalinity, free CO_2 and conductivity

Collect these samples from 1-meter below the surface and 1-meter above bottom with a Van Dorn water sampler; dispense aliquots into 250-ml gas bottles and hold in a dark, cool place if available. Immediately on return to the field laboratory remove without shaking 100 mls to a beaker. To determine free CO_2, record pH and titrate with 0.002N NaOH until a pH of 8.3 has been reached. Multiply titre by 0.88 to obtain mg/l free CO_2.

To determine alkalinity, remove an additional 100 mls, read pH, record and slowly add 0.01 N H_2SO_4 until the pH has decreased to 4.3. Record millilitres in titration and multiply titre by 5 to obtain alkalinity. If necessary use fine buret.

It is extremely important to check the pH meter with standards (at least two buffers are required) at the beginning and end of analyses.

Determine conductivity on residual water with temperature adjusted to near 25C. Check meter periodically using standard KCl solution. Record water temperature at time of measurement if different than 25±2C.

3. Nutrient analyses and chlorophyll

For each composite sample (surface to 1% light-level) and point-source hypolimnion sample the following sub-samples are to be collected, preferably all taken from a single Van Dorn

or 40-oz. haul. Label each bottle as to location, date, analyses to be done and destinations (Chem. I or Chem. II).

a. one 500-ml plastic bottle - to be frozen, N & P Chem I (fill bottle only 2/3).
b. One 500-ml plastic bottle - not frozen, Si, Fe, Mn, Chem. II.
c. one 175-ml bacteriology sample bottle - not frozen, Carbon, Chem. II.
d. one 40-oz bottle - with 5 mls of Mg CO_3 solution immediately added, chlorophyll, Chem. I. Preserve on cruise - but not on Chemung Lake.

The following details should be adhered to when securing euphotic zone samples.

1. After determining the Secchi disc depth, measure out twice the amount of rope and mark it with a clip or a knot. This is the depth through which the water sample for chlorophyll will be collected.

2. Label the water sample bottle with lake, depth and date.

3. Place the sample bottle in the composite sampler (Figure 3a) and secure it by jamming a cap into the space between the bucket and bottle.

4. Lower the sampler as rapidly as possible to the predetermined sampling depth and raise the device as rapidly as possible. If the bottle is not full, repeat this operation until it is full or adjust the speed of lowering and raising so that the bottle is full when it reaches the surface. As described previously, the object is to collect water from all parts of the measured sampling column (Figure 3b).

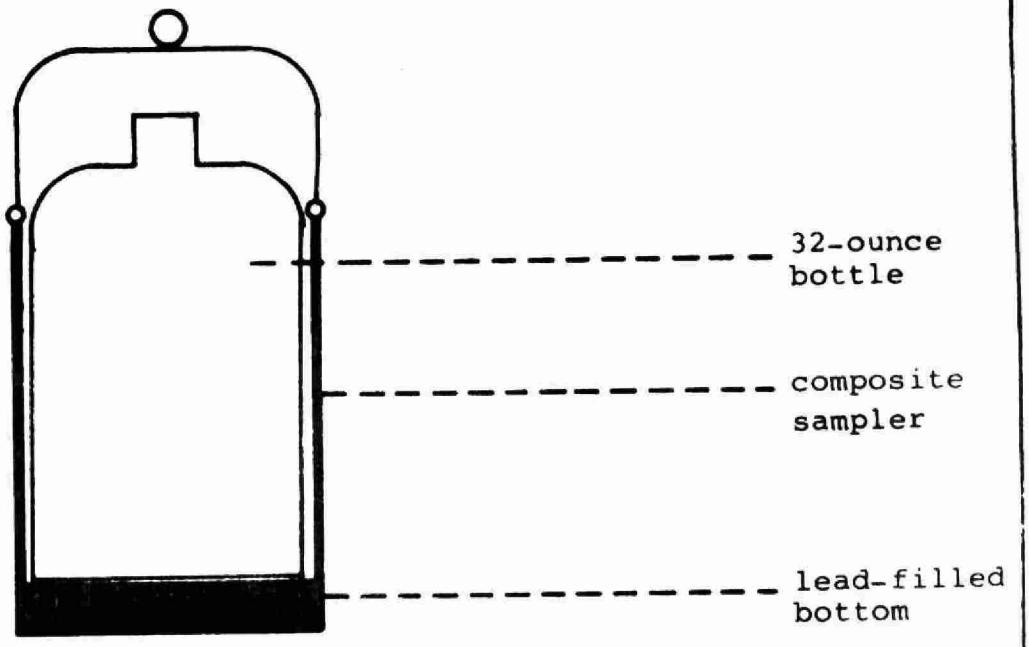


Figure 3a

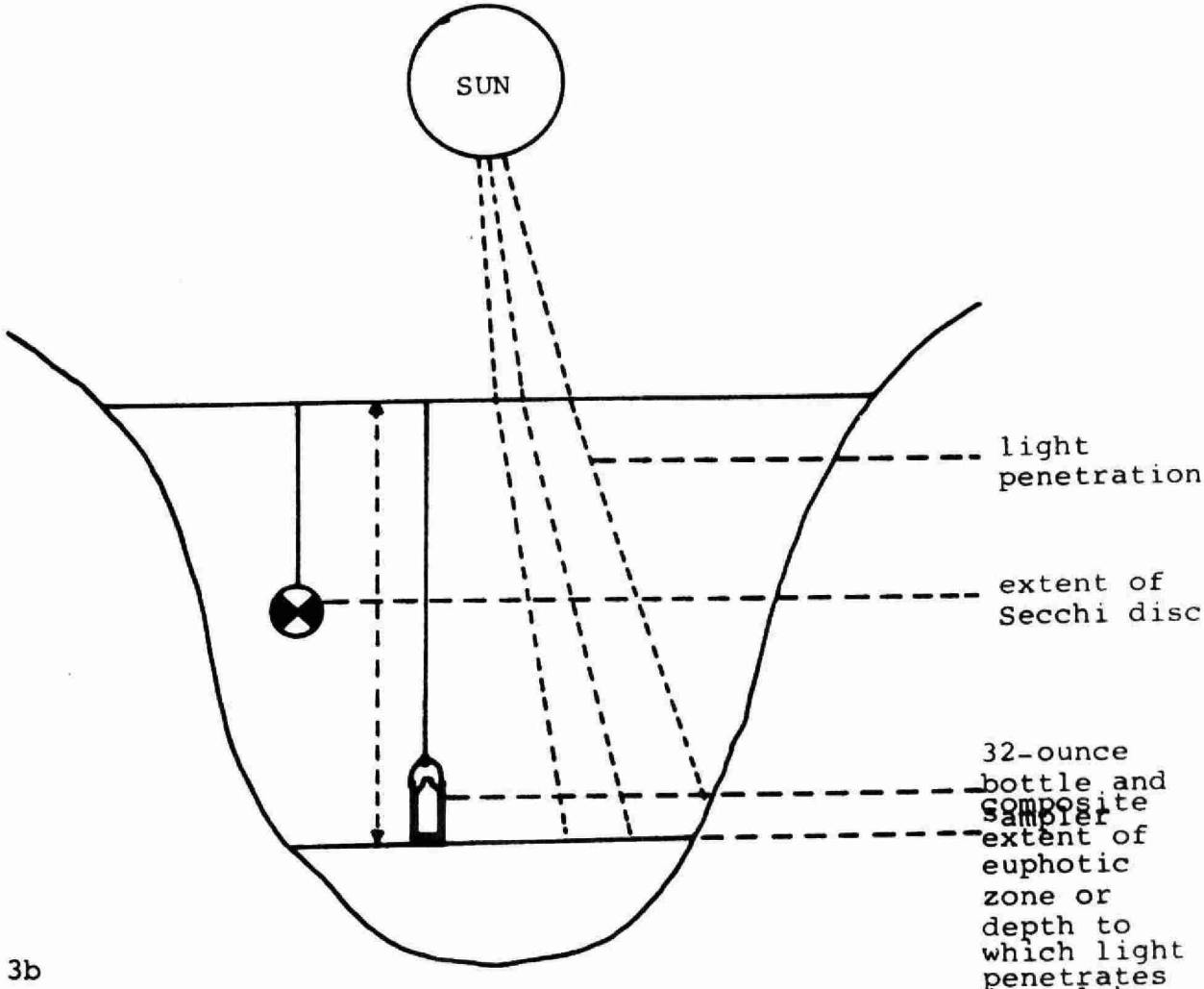


Figure 3b

Figure 3a. Diagramatic representation of a composite sampler and 3b. method of sample collection for chlorophyll analyses.

5. Add 10-15 drops of a 2% magnesium carbonate solution to preserve the chlorophyll sample as soon as possible after collection. (Note: shake magnesium carbonate solution vigorously before use).

The chlorophyll samples will be filtered at the field lab according to the following procedure:

Place a 1.20 u MPF in unit and wash filter 4 times with 25 ml portions of the sample. Discard the 100 mls of filtrate and wash receiving flask with distilled water.

Filter a portion of the sample up to 900 mls. Remove filter containing chlorophyll onto filter pad in plastic container, label and store in cooler until shipment to lab (Chem. I). If sample cannot be filtered immediately, preserve with 2.5 mls of $MgCO_3$ solution - ensure that this is marked on sample reception sheet. It is important that the exact volume of water (in mls) filtered be noted with the filter paper. Do not exceed 15 inches Hg. filtering pressure.

For instructions on what to do with the filtrate see section CHEMISTRY OF BIOLOGICAL MATERIALS.

4. Basic Chemical Characteristics:

On alternate cruises 32-ounce water samples will be secured through the euphotic zone at each sampling site for calcium, sodium, magnesium, potassium, turbidity, hardness, sulphate and colour, and submitted to the Chemistry I section for analyses.

5. Inorganic carbon re: Primary productivity

Water is collected in 40-oz glass bottles from the same Van Dorn sample as primary productivity sub-samples. In the field lab, the pH is adjusted to at least 11.0 with NaOH.

Because the base must contain minimal carbon, pellets of NaOH washed in 10% HCl can be introduced into each of the bottles. Alternately, 50% analytical-grade NaOH in small dropper-bottles (a fresh bottle for each depth series) will be satisfactory. Samples will be submitted to the attention of Dr. Berg, Chemistry II Section.

D. CHEMISTRY OF BIOLOGICAL MATERIALS

1. Nutrient content of phytoplankton

This will be estimated by difference between analyses on whole-water samples and filtrates of the same water.

Place 200 mls of the filtrate collected from the chlorophyll sample in a plastic bottle and freeze it. Label for Kjeldahl nitrogen, ammonia, nitrate, nitrite, total phosphorus and soluble phosphorus (to Chemistry I).

E. PHYTOPLANKTON

1. Collection and enumeration of algae

(a) determine the extent of the euphotic zone i.e. depth of 1% incident light level (see section on Physical Properties of Lake Water).

(b) Collect a 40-ounce sample from a column extending to the 1% incident light level by drawing the sample alternately up and down through the water column. Trial and error will determine the rate at which the sampler need be drawn through the column so that the bottle is filled just as the sampler breaks the surface.

(c) preserve the sample at the time of collection with enough Lugol's Iodine to impart a dark orange colour to the water (i.e. about the colour of lager beer).

2. Primary productivity

(a) Chemung Lake - ^{14}C

Collect samples by means of a Van Dorn water sampler from six depths extending to or slightly below the estimated 1% incident light level. Collect the first sample from near the surface. The remaining samples should be collected at approximately 0.5 - 1.0 meter intervals, with those nearer to the surface generally being closer together. Water from each sample is dispensed into three clear and one dark (opaque) glass-stoppered 390 -ml bottles and one 175 ml glass bottle for inorganic carbon analysis. Add exactly 1 ml of $NaH^{14}CO_3$ to each of the four samples with a calibrated hypodermic syringe.

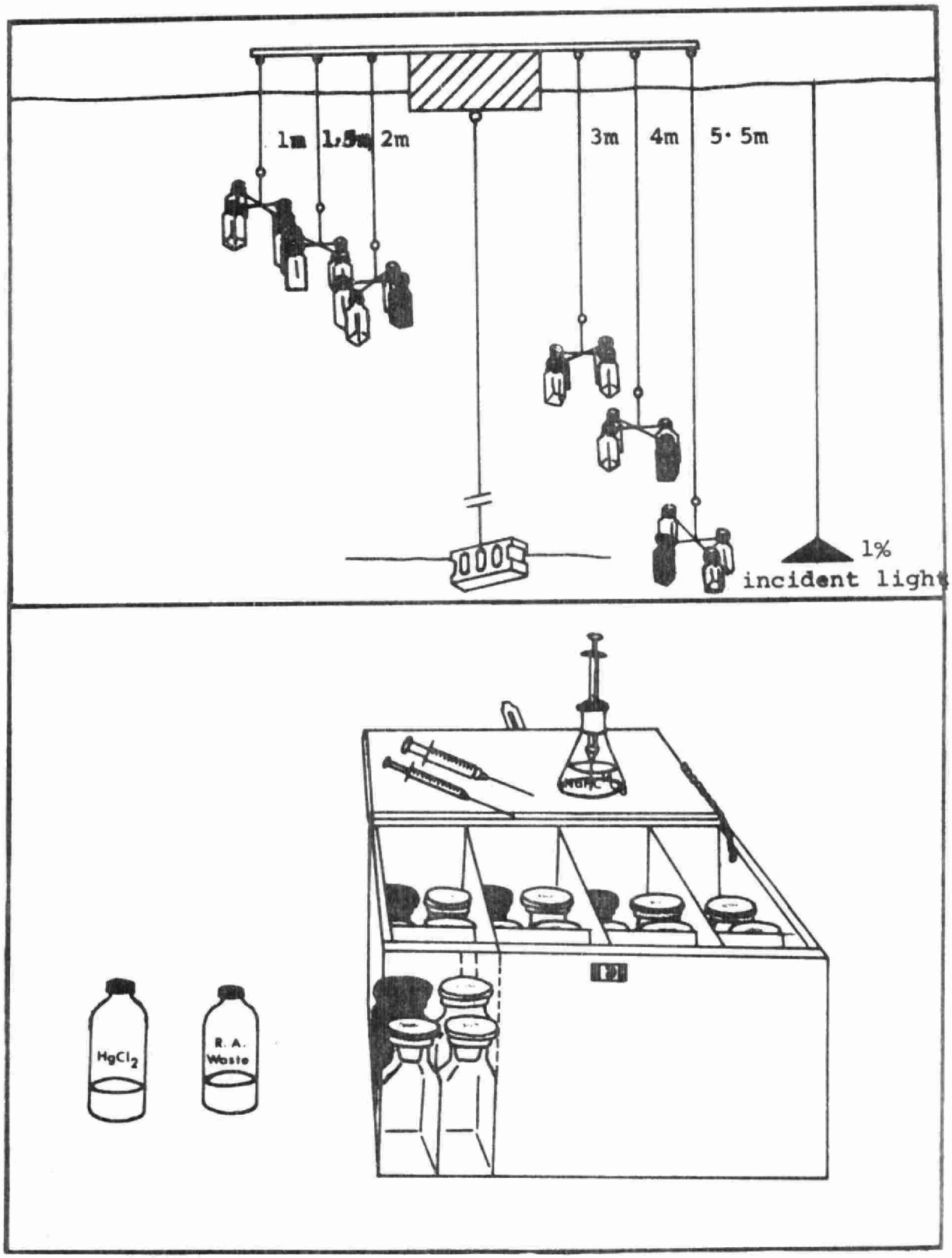


Figure 4. Diagrammatic representation (a) for determining photosynthetic activity of photic zone and (b) of field equipment: 10 ml syringe; 25 ml syringe; 1 ml syringe and sterile ^{14}C reservoir; light and dark bottles; $HgCl_2$ and container for radioactive waste material.

(a) Chemung Lake - 14_C (contd.)

Extreme care must be taken to ensure that the clear bottles are not exposed to light during the innoculation procedures (i.e. possibly by placing the bottles in black cloth sleeves). Clamp the french squares on the spacers and suspend the bottles for 4-6 hours at the depth from which the water was collected (see Figure 4a and b).

Primary productivity is arrested by adding mercuric chloride* (0.7 gm $HgCI_2$ per 1,000 ml of water) and within several hours, the algae are removed on 0.45 u Millipore filters using a vacuum pump and pressure not exceeding 15 in. of mercury. Each filter is rinsed with four separate 15 ml aliquotes of distilled water, dried with an IR light source at a distance of 0.2 - 0.4 metres and placed in a scintillation counting medium of 0.01% 1,4- bis - 2-(5-phenyloxazolyl) - benzene and 0.4% 2.5 - diphenyloxazole in toluene.** The samples will be transported to the Ministry of Environment Division of Laboratories in Toronto where the ^{14}C activity of the algae will be determined with a Packard Tricarb spectometer.

The uptake of ^{12}C can be estimated from the equation:

$$\frac{^{12}C \text{ assimilated}}{^{12}C \text{ available (W)}} = \frac{^{14}C \text{ assimilated (Y)}}{^{14}C \text{ available (Z)}} = K$$

from which:

$$^{12}C \text{ assimilated} = K.\frac{Y}{Z} (W) \text{ mg } C/M^3$$

where:

Y is the activity of filtered phytoplankton corrected for dark bottle assimilation and self absorption.

* 6 mls in 190 ml bottle and 10 ml in 300 ml BOD bottle.
**Sulphur free.

W is the inorganic carbon concentration in the lake water (mg C/M^3).

Z is the activity of inorganic carbon added to the bottles and

K is 1.05 and corrects for isotopic discrimination.

Primary productivity estimates with radioactive carbon will be completed every week at four sampling sites in Chemung Lake while the dissolved oxygen method will be carried out on alternate weeks.

(b) Chemung Lake - Oxygen Light and Dark Bottle Technique

The basic technique includes enclosing water samples containing natural phytoplanktonic populations in glass bottles and exposing the bottles to light. Concomitantly, an aliquot of the original sample is maintained in a darkened bottle for the same length of time and at the same temperature as the illuminated samples. Sampling depths are chosen as described under the section entitled "Chemung Lake - ^{14}C".

The initial concentration of dissolved oxygen (DO_1) can be expected to fall to a lower value (DO_2) in the darkened bottles by respiration, and to attain a third value (DO_3) in the clear bottles according to the differences between photosynthetic production and respiratory consumption. If other processes involving oxygen are considered to be negligible, and if one assumes that respiration is not altered by illumination then:

(a) $DO_1 - DO_2$ represents respiration per unit volume during a specific time interval.

(b) $DO_3 - DO_1$ represents photosynthesis per unit volume during a specific time interval.

(c) $(DO_3 - DO_1) + (DO_1 - DO_2) = DO_3 - DO_2$ represents the gross photosynthetic activity per unit volume during a specific time interval.

It should be emphasized that the difference $DO_3 - DO_1$ does not necessarily represent the actual net photosynthetic activity of the plant communities enclosed in the light bottles, as oxygen may have been consumed by both bacteria and animals. Additionally, the plant cells themselves would use oxygen through respiratory activities. The technique; therefore, is commonly used to measure gross photosynthesis. Unless estimates of net oxygen evolution and respiration are required, it is not necessary to determine the oxygen content of the initial water sample, although it is good practice to do this as an overall check on the method.

Dissolved oxygen can be determined by either chemical (Winkler method) or electrochemical means. One definite advantage of the Winkler method is that it is precise (about ± 0.02 mg/l in a single determination), and subsequently can be quite effective in eutrophic waters. A second advantage is that all biological activity in the glass enclosures can be simply arrested in the field. Titrations can then be carried out in the more suitable environs of the laboratory.

(c) Balsam Lake to the Bay of Quinte - Shipboard

Five compartments which allow for passage of 100%, 64%, 48%, 23% and 3% incident sunlight have been constructed and mounted on the cruising vessels HOBO and TURTLE II. Continuous flow of water taken from a depth of .2 metre will be effected by a pump system designed to deliver a uniform flow through the chamber and thus maintain a constant temperature.

Samples for incubation must be collected from depths receiving light intensities exactly similar to the light conditions of each chamber. The following directions should be adhered to for determining sampling depths.

1. At each station, determine light levels (microamperes) at each metre of depth to the limit of the euphotic zone. A reading immediately below (i.e. 0.1 metre). The surface will serve as a reference point (i.e. 100% light).

2. The data for the reference point and each metre are plotted on a 2 or 3 cycle semi-log paper with depth along the X axis and light intensity along the Y axis (Figure 5).

3. A straight line will materialize through the points.

4. Calculate microampere values for 64%, 48%, 23% and 4% of the 100% incident light reading, "mark-off" the computed values on the curve and "read-off" corresponding sample collection depths.

5. Primary productivity at each cruise station will be determined on each visit, using radioactive carbon injection techniques (see section entitled "Chemung Lake ^{14}C). Only one dark and one light bottle per depth will be incubated.

6. It should be emphasized that separate 6-ounce samples need be collected for each depth and treated in a manner described in the section entitled"Inorganic Carbon re: primary productivity".

(d) Type of Productivity Day Curve

Time permitting, individual productivity estimates will be taken between dawn and dusk to determine whether productivity follows daily insolation or is more efficient before mid-day.

F. AQUATIC MACROPHYTE ASSESSMENT

1. Chemung Lake Study

The following directions have been prepared as a guide for the field and laboratory techniques associated with the aquatic macrophyte aspects of the study.

(a) Field methodology

1. Samples will be collected at fifty stations in the southern end of Chemung Lake on a routine weekly basis.

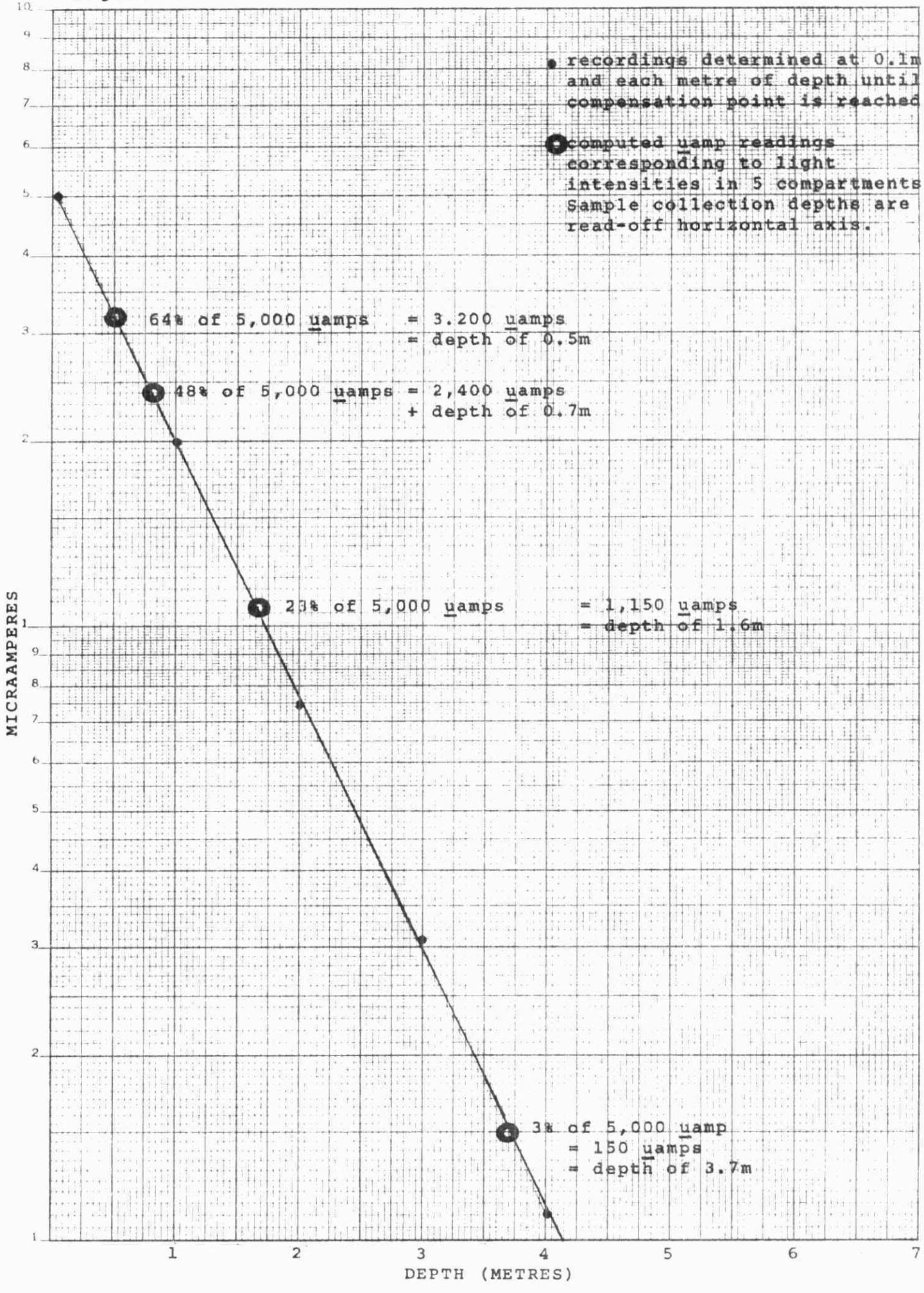
2. A ¼square metre quadrat (½ x ½ metre) made of wood and having negative buoyancy owing to six pounds of lead weight will be used to subtend each sampling area.

3. The quadrat which is secured by a rope to the boat is thrown at random into the lake. The boat should be anchored prior to throwing to ensure the quadrat is not disrupted by movement of the boat. Additionally, at least one person should be on the weed survey on a continous basis to ensure that differences in opinions regarding sampling locations do not vary.

4. Notes should be maintained on water depth, water clarity, type of substrate, species present in the area (not necessarily in the quadrat), water temperature (surface and bottom), relative height of the plants, seeding of plants (when just noticed), accumulation of marl deposits (relative to plants and in different parts of the lake.)

5. Quadrats must be cropped completely. Weeds are washed and separated according to species and placed in water-free plastic bags and kept out of the sun for shipment to the Peterborough Mobile Laboratory.

Figure 5.



6. Samples should be taken of all stages of plant growth and associated fruiting bodies (immature and mature). Additionally, unknown plant species should be collected, especially those which develop late in the season. The aforementioned can be placed in a coloured plant preservative for three days only, after which they can be placed in a clear plant preservative. Bob Stedwill has advised me that two sample representatives are better than one sample. All samples should be placed in 4 oz. jars and tagged for date of collection, location and collector, etc. Herbarium presses will be available.

(b) Laboratory methodology

1. Plants brought in from the field must have excess water removed as soon as possible after delivery, preferably by sponge or paper towels. Fresh weights must be obtained on the day of collection and recorded on the Field Data Sheet.

2. Samples are then placed in forced air drying ovens.

3. Dry weights are recorded on Field Data Sheets the following day.

4. Results for each week must be summarized on Weekly Data Sheets.

5. Dry plant samples collected during the last week of each month must be combined according to species. A sub-sample (approximately 25 gm) of each species will be sent to Toronto for analyses including: loss on ignition (LOI), phosphorus content (mg/gm dry weight) and nitrogen(mg/gm dry weight).

(c) Projects for consideration

A calculator is available for computation of percent water and other data.

2. A running account of primary production of each species in terms of total bromass (dry weight) can be maintained.

3. Preparation of maps delineating the location and extent of macrophyte cover (not necessarily from sampling sites) could be carried out.

4. Graphs and charts may be prepared to indicate seasonal production, species succession and nutrient content (as the data becomes available) for a number of species.

5. A herbarium collection could be maintained for all species encountered during the season. Attempts should be made to collect plants at varying stages of maturity.

2. Canal Lake to Bay of Quinte Study

During August, an assessment of existent plant bromass, percent cover, and species composition will be made by Mrs. I. Wile and Mr. B. Stedwill between Canal Lake and the Bay of Quinte. Suitable methods will be determined at a later date.

G. SPECIAL INVESTIGATIONS

1. Biological Survey Investigations

Mr. G.E. Owen, Regional Biologist will be carrying out a number of spot surveys in connection with waste discharges to the main stem and tributaries(near main stem). Specific objectives for each survey include an assessment of the degree and extent of effects on water quality and aquatic biota, the documentation of water use conflicts and the delineation of proposed mixing zones. The following list provides a breakdown of the planned surveys.

SURVEY	WATERCOURSE	WASTE SOURCE
Primary		
Lindsay	Scugog River and Sturgeon Lake	Lindsay municipal Union Carbide Ltd.
Peterborough	Otonabee River	Peterborough Municipal Brinton Carpets Ltd. C. G. E. Co. Ltd. OMC of Canada Ltd. Sargent Hardware of Canada Ltd.
Hastings	Trent River	Breightaupt Leather Co. Ltd.
Cambellford	Trent River	Cambellford municipal Breightaupt Leather Co. Ltd.
Lower Trent	Trent River	Frankford Sanitary Batawa Miller Brothers Ltd. Bata Shoes Domtar Newsprint Ltd.
	Rawdon Creek	Stirling Sanitary
Secondary		
Omemee	Pigeon River and Pigeon Lake	Sanitary
Lakefield	Otonabee River	Lakefield municipal Grove School sanitary.

SURVEY	WATERCOURSE	WASTE SOURCE
Secondary (contd.)		
Fenelon Falls	Sturgeon Lake	Fenelon Falls Secondary - sanitary.
Percy Boom	Trent River	Warkworth Penetentiary - sanitary.
Port Perry	Scugog Lake	Sanitary
Additional		
Fenelon Falls	Sturgon Lake	Municipal
Minden	Gull River	Municipal
Bobcaygeon	Pigeon Lake	Municipal
Bridgenorth	Chemung Lake	Municipal
Marmora	Crowe River	Municipal
Norwood	Little Ooze River	Municipal

2. Aerial photography - assessment of vascular aquatic growths.

During the latter part of August, aerial photographs for the entire shoreline between Amherst Island and Balsam Lake will be acquired. Areas of responsibility, type of film and flight plan details will be decided in the near future.

3. Nutrient regeneration

Sufficient daily data have been gathered from a deep, thermally stratified lake (Stony) in 1971 to determine the rates of nutrient accumulation and oxygen depletion in the hypolimnion to allow this aspect of the study to be discontinued.

Mr. D. Wright will be continuing his study to evaluate the effects of nutrient regeneration from sediments on phytoplankton communities under aerobic conditions. Work on this aspect of the programme will be carried out in Chemung Lake and the Bay of Quinte.

4. Water Chemistry Investigations

A detailed anion-cation (including heavy metals) balance will be obtained from composites taken through the euphotic zone at each course station in June, August and September.

5. Chemistry of Rainfall

Rainfall samples will be collected and submitted for pH, sulphate, inorganic and total carbon analyses throughout the summer and will serve as reference samples for Mr. B. Fallis currently studying the effects of reduced pH and heavy metals on fish populations in the Killarney area of the Province.